RESISTANCE OF SURFACE LAYERS TO SELECTED TRIBODEGRADATION FACTORS

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Abstrakt

Contribution presents the results of research focused on resistance of surface layers to selected tribodegradation factors. Research is focused on the renovation of dies for hot work. Newly created renovation layers made with new types of filler materials are compared with conventionally used renovation materials. X37CrMoV5-1 was chosen as the die base material, which was hardened and tempered to a working hardness of 500 ± 15HV. The experiments are carried out practical measurements of mechanical properties of cladding. The quality of cladding was evaluated in tribological conditions of adhesion wear (ČSN EN 1071-13) and abrasive wear (STN 01 5084).

Introduction

Currently, the emphasis is on reducing production costs and making production more efficient. Here comes the word renovation, which was created as a way of financially satisfy maintenance of machinery and equipment in operations, not only in the engineering sectors. Tool life is particularly difficult for hot forming tools due to a large number of factors affecting their tool life. The complexity of the problem of the durability of cavity forming tools for hot bulk forming is due, among other things, to a change in the influence of individual factors with a change in the shape and dimensions of the products. The dies are subjected to complex stresses during work. The basic factors affecting the service life of dies include dies material, dies construction, dies production method, dies heat treatment method and quality, dies thermal and mechanical stress, forging conditions. The dies operate under conditions consisting of many factors which can be further subdivided into external (material and temperature of the forged blank, used technological equipment, heating and cooling conditions, forging cycle, type of lubricant and type of lubrication, etc.) and internal (forging shape). , weight of forging, distribution of deformations, design of the groove groove, degree of deformation, forging pressure in the cavity. Welding technologies, which have emerged as a way of financially satisfy maintenance of machinery and equipment in operations in the engineering sectors, play an important role. The paper is focused on the evaluation of resistance of functional layers created by welding under tribodegradation stress. [1-4]

Methodology of experimental works

For experimental work was used die material - X37CrMoV5-1 (1.2343, STN 19552), table 1, hardened and tempered to HRC 49 ± 1 (500 ± 15 HV). Conventional Cronitex RC44 (N1, 573 HV1), Dievar TIG-WELD (N3, 572 HV1), UTP A 673 (N4, 638 HV1) and experimental N2 (646 HV1) and N5 (505 HV1), tab.2. The quality of cladding deposit was evaluated by NDT tests - visual inspection (STN EN ISO 17637), capillary method (STN EN ISO 23277), ultrasonic inspection (STN EN ISO 11666). Tribological properties of cladding welds under conditions of abrasive wear (STN 01 5084) and adhesion wear (ČSN EN 1071-13) were determined.

Tab.1 Chemical composition of material X37CrMoV5-1 [% wt.]

C	Mn	Si	P	S	Cr	Mo	V	Fe
0,32-0,42	0,20-0,50	0,80-1,20	max 0,030	max 0,030	4,50-5,50	1,10-1,60	0,35-0,60	zvyšok

Tab.2 Chemical composition of wires of filler materials [% wt.], Fe Bal.

	Mark			Chemical composition						
	Title	C	Mn	Si	Cr	Al	Mo	W	V	Ti
N1	Cronitex RC44	0.35	0.6	0.7	5,3	0.03	1.5	0.4	0.8	
N2	Experiment 1	0.32	1.2	0.8	3,7	0.02	2.7		0.8	
N3	Uddeholm Dievar Tig-weld	0.32	0.4	0.3	4,9		2.1		0.6	
N4	UTP A673	0.35	0.4	1	5		1.5	1.3	0.3	
N5	Experiment 2	0.25	0.7	0.5			3.4			0.7

Renovation was carried out using tungsten electrode welding technology in shielded gas atmosphere (TIG) - method 141 (STN EN ISO 4063). Cladded was the base material X37CrMoV5-1 with dimensions of 125x125 mm and thickness of 35 mm, where three cladding layers were welded. Direct current was used on the Transtig 2200 job. Cladding was performed with a tungsten-cerium electrode designated WC 202.4 with a 30 ° ground electrode tip. Feeding of the filler material was manual. The shielding gas used was argon with the working designation ArGN46, which was fed to the weld site by a ceramic nozzle with an internal diameter of 9.5 mm, at a gas consumption of 8 l / min.

Abrasive wear was evaluated on APGi equipment of its own production. Each overlay was loaded with a 1 kg counterweight at a 45 meter path. The abrasive medium used was corundum abrasive paper of P120 grain size. Ball-on-Disc adhesive wear was performed on a Bruker CETR UMI Multi-Specimen Test System. Test parameters used: the test was carried out at 500 ° C, the normal load in the z-axis was 20N, the ball-to-circle diameter of 14 mm, the test time 60 min, the test speed 4 mm / s, the ball type Ø 6 mm - Al2O3, roughness of the test sample Ra 0,8 μm (STN EN ISO 4287). The 3D display of the results after the Ball-on-Disc test was performed using the "treshold" method based on the STN EN ISO 4287 standard.

Experimental results and discussion.

The abrasion resistance test was carried out on an APGi, with firmly bonded abrasive. Samples were monitored for weight loss before and after the test. The weight loss of the base material (E) is higher compared to the samples of welded materials N1 to N5 and reached 0.0501g. The lowest value of wear shows the N4 deposit, reaching 0.0309 g. Other weight loss values ranged between: N1 = 0.0419 g, N2 = 0.0398 g, N3 = 0.0379 g, and N5 = 0.0453g.

Adhesion wear evaluation was performed on a Bruker CETR UMI Multi Specimen Test System, performed at 500 ° C. After the adhesion wear test, the AXIO Imager M2 optical microscope was evaluated for wear marks on the experimental samples tested. Based on these measurements, we can conclude that the widest traces in the materials after the adhesive wear test reached the N5 surfacing material with an average value of 754 μm, and the lowest average track widths were measured on the N1 = 504 μm surfacing materials, N4 = 503 μm. Other materials have reached an average adhesion wear trace: E = 635 μm, N2 = 656 μm, N3 = 575 μm

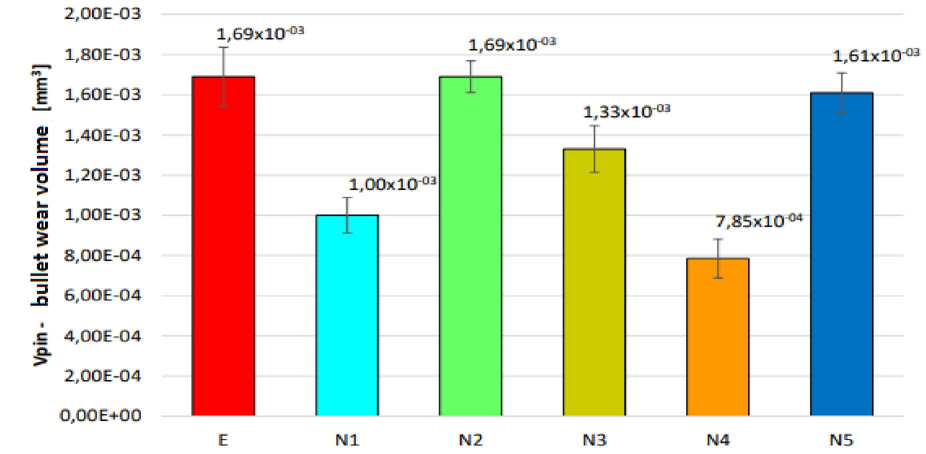

Fig. 1 Weight loss of welds N1 to N5 and standard E

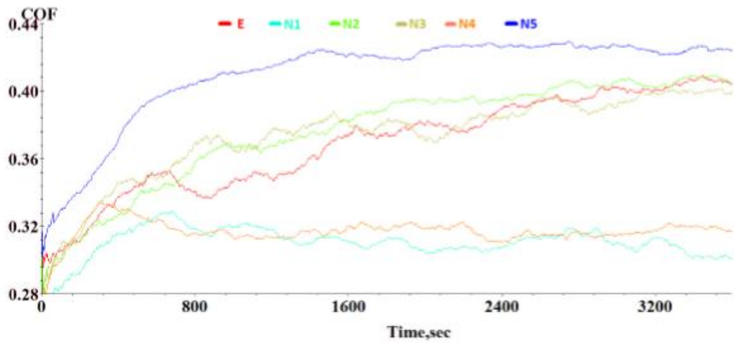

Fig. 2 Comparison of the coefficient of friction for the standard and the weld deposit

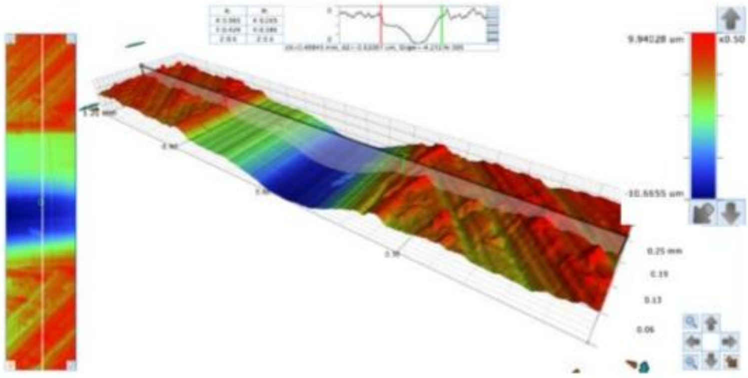

Fig. 3 3D depiction of the Wear Wear Path N1 after Wear

Conclusion

TIG welding technology was chosen for the renovation of dies. Conventionally used and newly conceived additive materials were evaluated. The quality of the weld deposit was evaluated under abrasive and adhesive wear conditions. Under abrasive wear conditions with a fixed bonded abrasive, the N4 UTP A 673 surfacing achieved best results due to its chemical composition and the presence of hard particles. Likewise, under the conditions of adhesion wear, the N4 and N1 cladding showed the best resistance to the stresses. The values of the coefficient of friction were lower than those of the standard. Experimental works have confirmed that the selected welding technology is suitable for the renovation of dies in demanding tribological conditions and the selected methods for the evaluation of the weld deposit quality provide relevant results. However, the quality of the weld deposit must also be determined by the structural composition of the individual layers and the mechanical properties of the weld deposit.

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